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09/696, 525

1 Amendments to the Claims:

2 This listing of claims will replace all prior versions, and
3 listings, of claims in the application:

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5 Listing of Claims:

23 Oct 2000

6 ① (Original) A symbol timing synchronizer for generating a timing
7 signal from a sampled input signal being a received input signal
8 sampled at a rate of the timing signal, the received input signal
9 being a continuous phase modulated signal modulated by a symbol
10 sequence generated from a precoded data sequence of an input data
11 sequence, sampled input signal having a sampled inphase component
12 and a sampled quadrature component, the symbol timing synchronizer
13 comprising,

14 an inphase isolator and a quadrature isolator for respectively
15 isolating the sampled inphase component and sampled quadrature
16 component of the sampled input signal for respectively providing an
17 inphase signal and a quadrature signal,

18 an inphase serial data demodulator and a quadrature serial
19 data demodulator for respectively receiving and filtering the
20 inphase signal and the quadrature signal for generating an odd
21 filter response and an even filter response, and for converting and
22 sampling the odd and even filter responses into odd data and even
23 data, the odd data and the even data alternately forming an
24 estimate of the input data sequence,

25 an inphase error magnitude generator and a quadrature error
26 magnitude generator for receiving and filtering the inphase signal
27 and the quadrature signal, for respectively generating and sampling
28 an inphase error magnitude signal and quadrature error magnitude

1 signal for respectively generating a sampled inphase error
2 magnitude signal and a sampled quadrature error magnitude signal,
3 an inphase mixer and a quadrature mixer for respectively
4 mixing the sampled inphase error magnitude signal with the odd data
5 into an odd error signal, and mixing the quadrature error magnitude
6 signal with the even data for generating an even error signal, the
7 odd data representing an odd sign of the inphase magnitude error
8 signal, the even data representing an even sign of the quadrature
9 magnitude signal, and

10 an oscillator means for generating the timing signal from the
11 even error signal and the odd error signal, the timing signal for
12 controlling the sampling of the inphase serial data demodulator and
13 the quadrature serial data demodulator and for controlling the
14 sampling of inphase error magnitude generator and a quadrature
15 error magnitude generator for generating the timing signal at a
16 rate of the symbol sequence.

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19 2. (Original) The symbol timing synchronizer of claim 1 wherein the
20 oscillator means comprises,

21 a loop filter for receiving the odd error signal and the even
22 error signal for providing a filter error signal,

23 a controlled oscillator for receiving the filter error signal
24 for generating the timing signal, and

25 a modulo counter for providing an odd timing signal for
26 sampling the inphase magnitude error signal, and for providing an
27 even timing signal for sampling the quadrature magnitude error
28 signal.

1 3. (Original) The symbol timing synchronizer of claim 1 wherein,
2 the inphase magnitude error generator generates the inphase
3 magnitude error signal from a difference between a filter response
4 of the inphase signal and an odd modulo count of the timing signal,
5 the inphase magnitude error generator serving to cross correlate a
6 principal Laurent component of the inphase signal with a gate
7 function relative to the odd modulo count of the timing signal, and
8 the quadrature magnitude error generator generates the
9 quadrature magnitude error signal from a difference between a
10 filter response of the quadrature signal and an even modulo count
11 of the timing signal, the quadrature magnitude error generator
12 serving to cross correlate a principal Laurent component of the
13 inphase signal with a gate function relative to the even modulo
14 count of the timing signal.

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16 4. (Original) The symbol timing synchronizer for claim 1 wherein,
17 inphase and quadrature serial demodulators respectively filter
18 principal Laurent components of the inphase and quadrature signals
19 for providing odd and even Laurent filter responses, and
20 inphase and quadrature serial demodulators respectively
21 sample the odd and even Laurent filter responses for generating the
22 odd and even data.

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24 5. (Original) The symbol timing synchronizer of claim 1 further
25 comprising

26 an input sampler for sampling the received signal into the
27 sampled input signal sampled at a rate of the timing signal.

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1 6. (Original) The symbol timing synchronizer of the claim 1 further
2 comprising,

3 a multiplexer for multiplexing the odd and even data into the
4 estimate of the input data sequence.

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6 7. (Original) The symbol timing synchronizer of claim 1 wherein,
7 the received input system is a Gaussian minimum shift keying
8 signal have a bit bandwidth product of $1/5$ and a modulation index
9 of $1/2$.

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11 8. (Currently Amended) The symbol timing synchronizer of claim 3
12 wherein,
13 the odd modulo count is $(2k+1)N$ where N is the modulo count of
14 the modulo counter, and
15 the even modulo count is $(2k)N$ where N is the modulo count of
16 the modulo counter, where k is a symbol index.

17
18 9. (Currently Amended) The symbol timing synchronizer of claim 1
19 wherein
20 the odd error signal is an e_{2k+1} odd error signal, and
21 the even error signal is an e_{2k} even error signal, where k is a
22 symbol index.

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10. (Original) The symbol timing synchronizer of claim 1 further comprising

a carrier phase synchronizer for generating a phase adjustment signal from a sampled phase adjusted input signal and the timing signal,

an input mixer for adjusting the received input signal into a phase adjusted input signal, and

an input sampler for sampling the phase adjusted input signal into the sampled phase adjusted input signal.

11. (Original) The symbol timing synchronizer of claim 10 wherein the carrier phase synchronizer comprises,

an inphase isolator and a quadrature isolator for respectively isolating the sampled inphase component and sampled quadrature component for providing an inphase signal and a quadrature signal,

an inphase serial data demodulator and a quadrature serial data demodulator for respectively receiving and filtering the inphase signal and the quadrature signal for generating an odd filter response and an even filter response, and for converting and sampling the odd and even filter responses into odd data and even data, the odd data and the even data alternately forming an estimate of the input data sequence,

an odd mixer and an even mixer for respectively mixing the even filter response and the odd data signal into an odd error signal and mixing the odd filter response signal and the even data signal into an even error signal, and

an oscillator means for converting the odd and even error signals into the phase adjustment signal.

12. (Original) A symbol timing synchronizer for generating a timing signal from a sampled input signal being a received input signal sampled at a rate of the timing signal, the received input signal being a continuous phase modulated signal modulated by a symbol sequence generated from a precoded data sequence of an input data sequence, sampled input signal having a sampled inphase component and a sampled quadrature component, the symbol timing synchronizer comprising,

an inphase isolator and a quadrature isolator for respectively isolating the sampled inphase component and sampled quadrature component of the sampled input signal for respectively providing an inphase signal and a quadrature signal,

an inphase early-late gate and a quadrature early-late gate for respectively filtering the inphase signal and the quadrature signal for generating an inphase gate signal and a quadrature gate signal, the inphase and quadrature early-late gates respectively serving to cross correlate the inphase and quadrature signals with gate functions in synchronism with the timing signal,

an inphase transformer and a quadrature transformer for respectively transforming the inphase signal and the quadrature signal for generating an inphase transformed signal and a quadrature transformed signal,

an inphase gate sampler and a quadrature gate sampler for respectively sampling inphase gate signal and the quadrature gate signal for generating a sampled inphase gate signal and a sampled quadrature gate signal,

an inphase transformer sampler and a quadrature transformer sampler for respectively sampling the inphase transformed signal

1 and the quadrature transformed signal for generating a sampled
2 inphase transformed signal and a sampled quadrature transformed
3 signal,

4 an inphase hard limiter and a quadrature hard limiter for
5 respectively converting the sampled inphase transformed signal into
6 odd data and the sampled quadrature transformed signal into even
7 data,

8 an inphase mixer and a quadrature mixer for respectively
9 mixing the sampled inphase gate signal and odd data into an odd
10 error signal and mixing the sampled quadrature gate signal and even
11 data signal into an even error signal, and

12 an oscillator means for generating the timing signal from the
13 even error signal and the odd error signal, the oscillator means
14 for controlling the sampling of the inphase and quadrature gate
15 samplers and the inphase and quadrature transformer samplers for
16 generating the timing signal at a rate of the symbol sequence.

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19 13. (Original) The symbol timing synchronizer of claim 12 wherein
20 the oscillator means comprises,

21 a loop filter for receiving the odd error signal and the even
22 error signal for providing a filter error signal,

23 a controlled oscillator for receiving the filter error signal
24 for generating the timing signal, and

25 a modulo counter for providing an odd timing signal for
26 sampling the inphase magnitude error signal, and for providing an
27 even timing signal for sampling the quadrature magnitude error
28 signal.

14. (Original) The symbol timing synchronizer of claim 12 wherein,
the inphase and quadrature early-late gates function as cross
correlators for cross correlating a filter response isolating
principal Laurent components of the inphase and quadrature signals
with a gating function,

the inphase gate signal is an inphase magnitude error signal
from the correlation of an inphase early-late gate filter response
of the inphase signal and the gating function that is in
synchronism with an odd modulo count of the timing signal, and

the quadrature gate signal is a quadrature magnitude error
signal from the correlation of a quadrature early-late gate filter
response of the quadrature signal and the gating function that is
in synchronism an even modulo count of the timing signal.

15. (Original) The symbol timing synchronizer for claim 12 wherein,
the inphase and quadrature transformers, transformer samplers
and hard-limiters respectively are inphase and quadrature serial
demodulators,

the inphase and quadrature transformer are principal Laurent
component filters providing the inphase and quadrature transformed
signals that respectively are odd and even Laurent filter
responses, and

the odd and even data alternately forming an estimate of the
input data sequence.

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1 16. (Original) The symbol timing synchronizer of claim 12 further
2 comprising

3 an input sampler for sampling the received signal into the
4 sampled input signal sampled at a rate of the timing signal, and
5 a multiplexer for multiplexing the odd and even data into the
6 estimate of the input data sequence.

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9 17. (Currently Amended) The symbol timing synchronizer of claim 12
10 wherein,

11 the received input system is a Gaussian minimum shift keying
12 signal have a bit bandwidth product of $1/5$ and a modulation index
13 of $1/2$,

14 the odd modulo count is $(2k+1)N$ where N is the modulo count of
15 the modulo counter,

16 the even modulo count is $(2k)N$ where N is the modulo count of
17 the modulo counter,

18 the odd error signal is an e_{2k+1} odd error signal, and

19 the even error signal is an e_{2k} even error signal, where k is a
20 symbol index.

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22 18. (Original) The symbol timing synchronizer of claim 12 further
23 comprising

24 a carrier phase synchronizer for generating a phase adjustment
25 signal from a sampled phase adjusted input signal and the timing
26 signal,

27 an input mixer for adjusting the received input signal into a
28 phase adjusted input signal, and

1 an input sampler for sampling the phase adjusted input signal
2 into the sampled phase adjusted input signal.

3
4 19. (Original) The symbol timing synchronizer of claim 18 wherein
5 the carrier phase synchronizer comprises,

6 a carrier inphase isolator and a carrier quadrature isolator
7 for respectively isolating the carrier sampled inphase component
8 and carrier sampled quadrature component for providing a carrier
9 inphase signal and a carrier quadrature signal,

10 an inphase sampler and a quadrature sampler for respectively
11 sampling at the rate of the timing signal the carrier inphase
12 signal and the carrier quadrature signal for providing a carrier
13 sampled inphase signal and a carrier sampled quadrature signal,

14 a carrier inphase transformer and a carrier quadrature
15 transformer for respectively transforming the carrier sampled
16 inphase signal and carrier sampled quadrature signal into a carrier
17 inphase transformed signal and a carrier quadrature transformed
18 signal,

19 a carrier inphase hard limiter and a carrier quadrature hard
20 limiter for respectively converting the carrier inphase transformed
21 signal and carrier quadrature transformed signal into a carrier odd
22 hard limited signal and a carrier even hard limited signal,

23 a carrier modulo counter for receiving the timing signal and
24 generating a carrier odd timing signal and a carrier even timing
25 signal,

26 a carrier odd sampler and a carrier even sampler for
27 respectively sampling at the rate of the carrier odd and even

1 timing signals for sampling the carrier odd and even hard limited
2 signals into carrier odd data and carrier even data,
3 a carrier odd mixer and a carrier even mixer for respecting
4 mixing the carrier quadrature transformed signal and the carrier
5 odd data signal into a carrier odd error signal and the carrier
6 inphase transformed signal and the carrier even data signal into a
7 carrier even error signal, and
8 a carrier oscillator for converting the carrier odd and even
9 error signals into the phase adjustment signal.
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